

REMARKS

I. Status of Claims

Claims 15-34 are pending. Claims 1-14 have been canceled without prejudice or disclaimer. New claims 15-34 have been added. Specifically, claims 1-11 have been rewritten as new claims 15-27 to conform to current U.S. patent practices. Claims 12, 13 and 14 have been rewritten as new claims 28-29, 31-32, and 34 respectively. Support for claims 28 and 29 is found in the specification on page 6, lines 25-27 and page 7, line 9. Support for claims 31 and 32 is found in the specification on page 6, lines 27-28, and page 7, line 9-10.

Additionally, claim 30 recites, *inter alia*, that the concentrated feed stream comprises about 80 wt.% 2-hydroxy-4-methylthiobutyronitrile. Support for new claim 30 is found in the specification on page 7, lines 15-16. Also, claim 33 recites, *inter alia*, that the dilute aqueous feed stream comprises about 50 wt.% 2-hydroxy-4-methylthiobutyronitrile. Support for this amendment is found on page 8, lines 24-25.

As such, the amendments are fully supported by the application as originally filed. Accordingly, no new matter has been introduced by these amendments.

II. The Rejections Under 35 U.S.C. §112, Second Paragraph and Traverse

The Examiner has rejected claims 3, 4, 13 and 14 under 35 U.S.C. §112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter of the invention.

Specifically, the Examiner contends that claim 1 requires a ceratin ratio of water to nitrile and that claims 13 and 14 require evaporation of water during the first step. The Examiner contends that since the evaporation has a direct effect on the ratio, it is not known whether the ratio limits the amount of water before or after evaporation.

Applicants respectfully submit that the Examiner's rejection under 35 U.S.C. §112, second paragraph, has been obviated in view of the amendments to the claims. As amended, claim 28 recites, *inter alia*, that the process further comprises: supplying the 2-hydroxy-4-methylthiobutyronitrile as a concentrated feed stream during the hydrating step (a); and maintaining the molar quantity of water to 2-hydroxy-4-methylthiobutyronitrile between 1 and 3. Claim 29 recites, *inter alia*, that the process further comprises: supplying the 2-hydroxy-4-methylthiobutyronitrile as a concentrated feed stream during the hydrating step (a); and maintaining that the molar quantity of water to 2-hydroxy-4-methylthiobutyronitrile is between 1 and 2.5. Claims 28 and 29 particularly point out and distinctly claim that the molar quantity of water to 2-hydroxy-4-methylthiobutyronitrile should be maintained within the recited ranges. It is desirable to maintain a low concentration of water to limit the successive hydrolysis of 2-hydroxy-4-methylthiobutyramide to 2-hydroxy-4-methylthiobutyric acid. (See specification, page 5, lines 13-16). As such, claims 28 and 29 are definite. Accordingly, Applicants respectfully request withdrawal of this rejection under 35 U.S.C. §112, second paragraph.

Additionally, the Examiner has rejected claims 3 and 4 under 35 U.S.C. §112, second paragraph, as indefinite. The Examiner contends that the claims recite both a broad recitation

and narrower statement of ranges/limitations. Responsive to the Examiner's comments, Applicants have rewritten the subject matter of claims 3 and 4 as new claims 17-18, and 19-20, respectively. In view of the amendments, Applicants submit that the Examiner's basis for rejection has been obviated. Accordingly, Applicants respectfully request withdrawal of this rejection under 35 U.S.C. §112, second paragraph.

Lastly, the Examiner has rejected claim 12 under 35 U.S.C. §112, second paragraph, as vague and indefinite because it uses the words "concentrated solution" without giving the concentration range the claim is referring to. Applicants respectfully disagree. Claim 12 has been rewritten as claim 28. Claim 28 recites, *inter alia*, a process further comprising supplying the 2-hydroxy-4-methylthiobutyronitrile as a concentrated feed stream during the hydrating step (a). Applicants respectfully submit that claim 28 the use of the term "concentrated" does not make the claim indefinite or vague. The breadth of a claim is not to be equated with indefiniteness. See M.P.E.P. § 2173.04. Applicants submit that one of ordinary skill in the art would readily understand and recognize that the term "concentrated" is used to modify feed stream, and refers to a high quantity of 2-hydroxy-4-methylthiobutyronitrile relative to other components. It is not necessary to place a numerical value on the "concentration" range. As such, the subject matter of claim 28 is clear and meets the requirements under 35 U.S.C. §112, second paragraph. Accordingly, Applicants respectfully request withdrawal of this rejection.

III. The Rejection Under 35 U.S.C. §103(a) and Traverse

The Examiner has rejected claims 1-14 under 35 U.S.C. §103(a) as unpatentable over Hsu et al., U.S. Patent No.: 5,998,664, or Ruest et al., U.S. Patent No. 4,524,077, in combination with Suchsland et al., U.S. Patent No. 5,847,207.

The Examiner alleges that a person of ordinary skill in the art at the time the invention was made would have been motivated to combine Hsu et al. and Suchsland et al. for the production of HMBA to arrive at the presently claimed invention. (See Office Action dated October 5, 2000, page 6). The Examiner contends that Hsu et al. provides for the high conversion rate of HMTBN to HMTBA but does not address the problems associated with residues and waste products. (*Id.*) The Examiner alleges that Suchsland et al. improves the problems associated with residues and waste products by addition of organic solvents to the suspension of the methyl hydroxy methylthiobutyric acid. (*Id.*).

Applicants respectfully traverse this rejection on the basis that this invention is not made obvious by the cited art, either alone or in combination.

In determining obviousness, 35 U.S.C. § 103 expressly requires consideration of the claimed invention "as a whole." For a *prima facie* case of obviousness, the Examiner must show some motivation for modifying the teachings of the references, and a reasonable expectation of success in doing so. *In re Vaeck*, 947 F.2d 488, 20 U.S.P.Q.2d 1438 (Fed. Cir. 1991). The mere fact that the prior art may be modified in the manner suggested by the Examiner does not make

the modification obvious unless the prior art suggested the desirability of the modification. *In re Gordon*, 733 F.2d 900, 902, 221 U.S.P.Q. 1125, 1127 (Fed. Cir. 1984).

As amended, the present invention recites, *inter alia*, a process for the hydrolysis of 2-hydroxy-4-methylthiobutyronitrile (HMTBN) comprising:

- (a) hydrating 2-hydroxy-4-methylthiobutyronitrile in a sulphuric acid medium to produce 2-hydroxy-4-methylthiobutyramide, wherein the molar quantity of sulphuric acid relative to the 2-hydroxy-4-methylthiobutyronitrile is between 0.6 and 0.88, the molar quantity of water to 2-hydroxy-4-methylthiobutyronitrile is between 1 and 3, and at a temperature of less than or equal to 60°C; and
- (b) hydrolyzing the 2-hydroxy-4-methylthiobutyroamide in the presence of an additional quantity of water to produce 2-hydroxy-4-methylthiobutyric acid in a reaction mass.

Hsu et al. (*Hsu*) teaches a continuous 2-step hydrolysis process to prepare HMTBA from HMTBN, using sulfuric acid and a molar quantity of sulfuric acid to HMTBN ranging from 0.7 to 1.5 and most preferably between 0.95 and 1.05 during steady state operation. (See *Hsu*, col. 5., lines 49-52) *Hsu* discloses that the hydrating step which converts 2-hydroxy-4-methylthiobutyronitrile into 2-hydroxy-4-methylthiobutyramide is carried out at a temperature between 40-70°C, preferably between about 60-65 °C. (See *Hsu*, col. 6., lines 16-18.) *Hsu* teaches that the hydrolyzing step which reacts the amide with water to form HMTBA in a plug

flow reactor (PFR) is run at a temperature ranging from about 70-120°C. (*Id.*, col. 7, lines 53-54).

However, this reference also reveals that based on the range of variables that were analyzed, i.e., acid/nitrile molar ratio from 0.6 to 1.2 and amide hydrolysis temperature from 90-120°C, an optimal range of conditions were derived for the fixed residence (or nitrile feed rate) tested. (*Id.* col. 15, lines 58-63). *Hsu* also discloses that within the range of 90-101°C and 1.0-1.2 acid/nitrile ratio, any combination of temperature and acid/nitrile molar ratio will result in a satisfactory product containing up to 0.05 wt.% amide and up to 0.05 wt.% nitrile. (*Id.* col. 15, lines 63-66 and Fig. 5). *Hsu* does not mention nor does it recognize the importance of simultaneously controlling the molar quantity of water to 2-hydroxy-4-methylthiobutyronitrile between 1 and 3, the molar quantity of sulphuric acid relative to the 2-hydroxy-4-methylthiobutyronitrile between 0.6 to 0.88, and the temperature less than or equal to 60°C in the hydrating reactor as presently claimed.

In the hydration step, the present invention requires a low sulfuric acid to HMTBN ratio (0.6 to 0.88), a low operating temperature (less than or equal to 60°C), in combination with a low water to HMTBN molar ratio (1-3) to ultimately achieve the high selectivity of the 2-hydroxy-4-methylthiobutyric acid (in excess of 98%). *Hsu* does not teach nor does it suggest that this particular combination of conditions would result in high selectivity of the 2-hydroxy-4-methylthiobutyric acid. As was mentioned previously, *Hsu* actually teaches away from utilizing an acid/nitrile ratio between 0.6 to 0.88 to achieve high selectivity of the 2-hydroxy-4-

methylthiobutyric acid stating that the preferred acid/nitrile ratio is 1.0-1.2. However, the present specification reveals that use of a sulfuric acid to nitrile molar ratio of between 1.0 and 1.2, the range taught in *Hsu*, results in large quantities of ammonium sulphates (solids) proportional to the quantity of acid introduced which causes a major problem for industrial discharges. The use of this acid/nitrile ratio results in a highly acidic medium which is very corrosive when hot and requires use of exotic (costly) materials of construction. (See specification, page 4, lines 1-10).

Additionally, the present specification states that the rate of the hydration of 2-hydroxy-4-methylthiobutyronitrile to 2-hydroxy-4-methylthiobutyroamide is inversely proportional to the quantity of water. (See specification, page 4, line 27 through page 5, line 6). As such, a molar quantity of water to 2-hydroxy-4-methylthiobutyronitrile between 1 and 3.0 is preferred. (*Id.*, page 5, lines 6-9). *Hsu* is completely silent with regard to this molar ratio. There is nothing in *Hsu* to suggest or motivate one of ordinary skill in the art to choose a low water/nitrile ratio to optimize the hydration rate.

Also, the present application discloses that the operating conditions for the hydrating step are chosen to limit the production of 2-hydroxy-4-methylthiobutyric acid. During this step, it is preferable to have no more than 5% 2-hydroxy-4-methylthiobutyric acid and greater than 95 wt.% of 2-hydroxy-4-methylthiobutyramide. (*Id.*, page 5, lines 17-9). All of the Examples in *Hsu* where the acid/nitrile ratio is less than 0.88 show that the hydrating reactors contain more than 5 % 2-hydroxy-4-methylthiobutyric acid. (See *Hsu*, Examples 10, 11, 13, 16, and 17, col.16-

18). In fact, use of an acid/nitrile ratio less than 1 results in poor selectivity even at an operating temperature greater than 60°C. (*Id.*) As such, *Hsu's* Examples suggest that mild operating conditions consisting of an acid/nitrile ratio of less than 1, even with a hydration reactor temperature in excess of 60°C, would not result in a high selectivity of 2-hydroxy-4-methylthiobutyric acid. As such, a skilled artisan, armed with the disclosure of *Hsu*, would not have reasonably expected that employment of an acid/nitrile molar ratio between 0.6 and 0.88, a hydration reactor temperature of less than 60°C and a water/nitrile molar ratio between 1 and 3 would readily result in high yield of 2-hydroxy-4-methylthiobutyric acid.

In view of the above discussion, Applicants submit that there is nothing in the *Hsu* reference to motivate one of ordinary skill in the art to modify the process of *Hsu* to include the specific combination of parameters necessary for hydrating 2-hydroxy-4-methylthiobutyronitrile in a sulphuric acid medium to produce 2-hydroxy-4-methylthiobutyramide, wherein the molar quantity of sulphuric acid relative to the 2-hydroxy-4-methylthiobutyronitrile is between 0.6 and 0.88, the molar quantity of water to 2-hydroxy-4-methylthiobutyronitrile is between 1 and 3, and at a temperature of less than or equal to 60°C as presently claimed. As such, the present invention is not obvious over the process disclosed in *Hsu*.

Ruest et al. (*Ruest*) does not cure the deficiencies of the *Hsu*. *Ruest* discloses a process for the production of 2-hydroxy-4-methylthiobutyric acid where 2-hydroxy-4-methylthiobutyronitrile is contacted with sulfuric acid and hydrolyzed to provide a light colored hydrolyzate containing 2-hydroxy-4-methylthiobutyric acid substantially free of unreacted nitrile

and intermediate amide. (See *Ruest*, col. 2, line 66 through col. 3, line 3). Preferably the sulfuric acid hydrolysis is carried out using approximately one mole of sulfuric acid per mole of 2-hydroxy-4-methylthiobutyronitrile feed. (See *Ruest*, col. 5, lines 28-30). The hydrolysis step is conducted at a temperature of between 25-65 °C. (*Id.*, col. 4, lines 59-60). The hydrolyzate is then contacted with a solvent in a liquid extraction system. Further treatment, including distillation, results in the production of the acid.

However, *Ruest* does not teach the operating conditions of the present invention. Specifically, *Ruest* does not teach nor does it suggest a hydrating step to produce 2-hydroxy-4-methylthiobutyramide simultaneously employing an acid/nitrile molar ratio ranging from 0.6-0.88, a water/nitrile molar ratio ranging from 1 to 3, and a reactor temperature of less than or equal to 60°C. In fact, contrary to the present invention where it is desirable to limit the amount of 2-hydroxy-4-methylthiobutyric acid produced during the hydrating step, the first step of *Ruest* results in production of significant quantities of 2-hydroxy-4-methylthiobutyric acid. As such, *Ruest* fails to teach every element of the claimed invention.

The Examiner relies on Suchsland et al. (*Suchsland*) stating that *Suchsland* discloses a continuous preparation of HMTBA by hydrolysis of the corresponding nitrile with sulfuric acid to form the amide followed by addition of water to produce the acid. The Examiner contends that *Suchsland* teaches the quantity of water at the hydrolyzing step is 35 wt.% relative to the whole reaction medium and that the aqueous solution of nitrile is concentrated by evaporation. (See Office Action dated October 5, 2000, page 5).

Applicants respectfully submit that the teachings of *Suchsland* fail to cure the deficiencies of the combination of *Hsu* and *Ruest*. There is nothing in *Suchsland* to motivate one of ordinary skill in the art to modify the hydrolyzing step of *Suchsland* to include selecting a molar quantity of sulfuric acid relative to the 2-hydroxy-4-methylthiobutyronitrile between 0.6 and 0.88, limiting the molar quantity of water to 2-hydroxy-4-methylthiobutyronitrile between 1 and 3 and maintaining the reactor temperature less than or equal to 60°C. *Suchsland* simply reveals that water may be introduced during the hydrolyzation step. The reference is silent regarding controlling the molar ratio of water to nitrile between 1 and 3, in the hydrating step to limit the production of the 2-hydroxy-4-methylthiobutyric acid as in the present invention.

Applicants also submit that the present invention is non-obvious over the combination of *Suchsland*, *Hsu* and *Ruest* since there is nothing in the prior art to provide the required motivation to pick and chose from the reference disclosures in order to arrive at the specific combination of operating conditions for the hydrating step which include a molar quantity of sulphuric acid relative to the 2-hydroxy-4-methylthiobutyronitrile between 0.6 and 0.88, a molar quantity of water to 2-hydroxy-4-methylthiobutyronitrile between 1 and 3, and at a temperature of less than or equal to 60°, and for the hydrolyzing step which includes the addition of water to produce 2-hydroxy-4-methylthiobutyric acid. As was previously mentioned, *Hsu* and *Ruest* fail to teach this specific combination of operating parameters. In fact, all the references cited by the Examiner are silent regarding the requirement for the molar ratio of water to nitrile ranging between 1 and 3. As was discussed earlier, this molar ratio of water to nitrile limits the

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production of 2-hydroxy-4-methylthiobutyric acid and to maximize the rate of the hydration of 2-hydroxy-4-methylthiobutyronitrile to 2-hydroxy-4-methylthiobutyroamide. As such, the combination of *Suchsland*, *Hsu* and *Ruest* does not teach or suggest every element of the presently claimed invention.

Accordingly, Applicants respectfully request that the rejection under 35 U.S.C. §103(a) be withdrawn.

CONCLUSION

Given the foregoing remarks, Applicants respectfully submit that all the pending claims are in condition for allowance. A prompt and favorable action is requested.

Please grant any extension of time required to enter this response and charge any additional required fees to our deposit account No. 06-916.

Respectfully submitted,

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